Neural mechanisms of rhythm-based temporal prediction: Delta phase-locking reflects temporal predictability but not rhythmic entrainment

Abstract:

Making predictions is a major adaptive brain function. Predicting the timing of upcoming events enables the brain to prepare to them, but how this is achieved is not clear. It is believed that in rhythmic environmental context, as in music and speech, temporal predictions are achieved by changing the properties of naturally-
occurring brain rhythms, a process referred to as oscillatory entrainment. We tested whether rhythm-based predictions have unique expressions in behavior and EEG by comparing rhythmic streams to arrhythmic streams that enable prediction based on memorizing repeating intervals, and to arrhythmic streams that do not enable prediction. We show that phase concentration of neural oscillations, a neural pattern often seen as an indicator of entrainment, occurs to a similar extent in predictive rhythmic and less-rhythmic streams. Using a computational model, we show that these results are not consistent with the predictions of an entrainment mechanism. However, we also show that when an expected event is omitted, memory-based predictions can be flexibly re-oriented, while rhythm-based predictions lead to immediate obligatory resource withdrawal and larger behavioral costs. This is consistent with resonance, a different prediction of entrainment models. This unique effect of rhythms is expressed in increased inhibition at unexpected times, but not increased facilitation at expected times. As a whole, the results identify the overlapping and distinct mechanisms of rhythm- and memory-based temporal predictions.

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